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MARKET SURVEY AND APPLICATIONS OF REMOTELY SENSED DATA TO RESOURCE BASED INDUSTRIES IN NEW BRUNSWICK

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CHAPTER 1

EXECUTIVE SUMMARY

This report is a survey of the feasibility of establishing a commercial remote sensing and geomatics(*) based capability for the Maritimes and located in New Brunswick. The survey clearly indicates that there is a broad user base for a remote sensing service, which has not been addressed, despite the relatively wide spread knowledge regarding the technology. The basic science and technology for such a service is in most respects mature, and contains few technical impediments. The fact that no service exists therefore seems to be an enigma until the background to the development and the evolution of operational remote sensing is taken into consideration. The advance of any new technology requires a considerable investment in marketing and applications development in order to define the correct product mix, forecast sales volumes and establish sales costs. This evolution must also include the development of new skills, in this instance by resource managers, in order to effectively utilize spatial information systems. An educational infrastructure and willingness by industry to invest in training programs, workshops and public awareness are also required.

New Brunswick has the infrastructure, data is available and requirements have been identified. However there still remains the need to bridge the gap between the scientific researchers and the operational users.

Implementation of a commercial capability under these circumstances will clearly benefit from an initial commitment by the provincial government's operational user departments, to fund pilot projects and orientation studies, and generally work with the new information facility, to establish cost effective methodologies. A period of three years is considered a minimum undertaking while the longer term markets, including the

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GEOMATICS is the term being used by professionals to describe the Geographic Information Systems industry.

commercial markets, nationally and internationally, are developed.

CHAPTER 2

BACKGROUND

Following discussions with members of the Science and Technology Secretariat of New Brunswick Department of Commerce and Technology in 1987, a consortium of three companies actively involved in remote sensing and geomatic technology was formed to evaluate the feasibility of establishing a Data Processing and Analysis service company in the Province.

During preparatory work on the proposal to establish the Radarsat Mission Control Centre in New Brunswick, it had become apparent that the data analysis portion of the program might have significant industrial development opportunities for the province. Remotely sensed data and geomatic products are forecast as one of the growth industries over the next decade. New Brunswick with its broad resource based industries has an existing market for application of this emerging technology. The potential for world wide export is also large. In order to qualify the magnitude of this market a survey to evaluate the needs and requirements of perceived users of this technology was proposed.

The consortium of Universal Systems Limited of Fredericton, Marshall Macklin Monaghan of Toronto, and under the leadership of MONITEQ Ltd. of Toronto, was awarded a contract to carry out this survey in February 1988. Universal Systems Limited is actively involved with geomatic systems. Marshall Macklin Monaghan provides a full range of surveying and mapping services including digital mapping and geographic information systems. MONITEQ is a Canadian leader in the remote sensing industry. The initiative was prompted by the government's commitment to the support of high technology industries within the province. It was realized that while there was a great dependence on the traditional resource industries of forestry, mining and fisheries in New Brunswick, there was scope for improving the management of resources within these industries and at the same time establishing a new commercial capability based on the emerging technologies of remote sensing and

geomatics.

Two fields in which New Brunswick has internationally recognized strengths are those of Geographic Information Systems (GIS) and Global Positioning Systems (GPS). It was believed that these represented a strong base on which to build and increase the technological strengths of the province. As the user of the largest spatial data base, the provincial government is committed to putting all data into a GIS system so as to have better and easier access to relevant data sets. Within the province, the forestry industry has been in the forefront for many years with the use of a GIS system to analyze spectral data related to that activity.

As GIS is a digital data base, a natural progression is to augment the existing data sets with remotely sensed digital data both from satellite and aircraft.

The overall objectives of this survey were to evaluate the potential for establishing an integrated remote sensing and GIS based commercial facility located in New Brunswick with particular emphasis on the following aspects:

- Confirm the existence and identify the extent of the market for services and products generated by such a facility.
- Forecast the volume for these services and products.
- Forecast the employment generated in the province through the implementation and operation of this new facility.
- Evaluate the potential role and specific applications for future Radarsat data within the province.

The results of this survey would allow the province and the members of the consortium to establish the viability of incorporating an enterprise to offer remotely sensed data within New Brunswick, and provide recommendations to the province to assist in planning for future industrial development and to aid in defining long term strategies.

CHAPTER 3

MARKETS

3.1 Introduction

Geographic Information Systems (GIS) are tools for managing and manipulating geographic or spatial information. A GIS incorporates data capture and data registration, but more importantly it allows the examination, analysis and interpretation of the spatial relationships of information for presentation as maps, charts, and other graphical and non graphical forms.

In Canada and world wide the emphasis on the utilization of GIS has been in the improvement in resource management by providing new and more cost effective information which cannot be adequately addressed by traditional approaches. Canada and the Maritimes have world leadership in this information technology, and the three companies, USL, MMM and MQ have established international reputations in their own particular niches within this market. The environment to exploit these opportunities with an integrated commercial capability appears to be opportune.

The launch of the first civilian remote sensing satellite in 1972 began a new era in our ability to monitor, understand and manage the earth's resources. Initially, there was a large degree of optimism about the benefits which remote sensing information would provide for environmental monitoring, resource exploration and management. Unfortunately, however, our ability to effectively utilize this information has not kept pace with the technology to acquire it. This has led to a feeling of disillusionment, and an attitude that remote sensing was capable only of providing "pretty pictures". The development of this attitude may to a large extent be due to the conceptual framework in which the majority of the remote sensing community has viewed this information. To a large extent it has been considered as essentially qualitative when the real strength of the information is its quantitative

MARKETS
Introduction

capability. This empirical approach has been the major influence on the way data processing systems have been designed and on the way we have interpreted the data.

From the beginning we have regarded remotely sensed data as "images", as though we were looking at the surface with our eyes. This has led to a highly qualitative perspective and as a result, much of the analysis peformed on this data has been statistical in nature. The data has been primarily sorted and displayed. While this approach is valid it fails to exploit the inherent quantitative nature which allows comparisons of data sets from the same geographic area taken at different times.

The objective of quantitative remote sensing is the formation of a spatial data set composed of inherently registered images. Each of these images is in effect a set of discrete measurements, or pixels, representing the reflectance pattern on the ground in a predefined region of the electromagnetic spectrum. The corresponding pixels from each of the images when taken together form the reflectance spectrum of the area to be covered on the ground by that particular pixel. The reflectance spectrum, in turn, characterizes the material present on the area of the surface represented by that pixel.

The operational application of remote sensing data sets to resource management requires that it be possible to relate the measurements one derives from the data to specific locations on the ground, and to be able to relate these measurements as exactly as possible with other data of the same geographic area, including maps, and data from other sources, regardless of the source of the data or the time at which it was acquired. This implies that one be able to interpret remotely sensed data from a given location on the surface of the earth independent of the data source. The requirement for precise location of each pixel independent of the source of acquisition implies that the data be transformed into a standard co-ordinate system as part of a geometric rectification process.

The expertise which the consortium brings in data capture and registration, applications development, data base management and manipulation, and survey and mapping, provides an ideal combination to pursue the application of this technology for a wide variety of markets.

To understand the markets for remote sensing and GIS products one must first be familiar with some of the applications.

MARKETS
Introduction

To help identify the applications, we have divided them into groups synonymous with the traditional industries throughout the Maritimes; these being forestry, mining and fisheries. Other specific market areas which offer considerable potential for integrated remote sensing and GIS data have also been identified.

3.2 Forestry

There is little doubt that the forest industry offers the largest market for remotely sensed data in New Brunswick. For many years the industry has used aerial photography for applications, such as mapping cuts and species identification. Infrared photography has been used to assess stand quality. These methods are tried and tested and there is no reason to question them. However, aerial photography has limitations, namely - each photograph has a limited aerial coverage, once developed the photograph has no way of being manipulated, and the numbers of photographs involved in some of the target areas makes the prospect of mosaicing (itself not an easy task) quite daunting. Hard copies of satellite images offer a cheaper method of aerial mapping; the 10 m panchromatic band of SPOT offers a quality product as good as aerial photography for many applications.

Remote sensing's major advantage to forestry is the many spectral bands available in a digital form. Infrared photography has been used and is accepted. Digital imagery however offers more infrared bands, and located in definitive spectral regions, for example, to indicate vegetation stress. Other applications are monitoring stand quality, disease, inventory and expected yields.

Of all the applications, disease monitoring has the most immediate impact. Huge areas of forest throughout Canada are being infected by various parasites which affect the trees' development. Many studies have been done, and are still being carried out, into methods of using remotely sensed data to predict the spread of the disease, and more effectively control this problem. These use a combination of spectral bands which have proven to be good indicators of vegetation quality. Throughout the Maritimes one of the biggest pests is the Spruce Bud Worm. Many millions of dollars are spent on spraying to help prevent losses. There is tremendous scope for the utilization of remote sensing to map the disease ridden areas, and more efficiently manage spray programs.

MARKETS
Forestry

Because of the huge areas involved, industry is looking at ways to try and assess stand quality. This would enable better management decisions for optimal harvesting. Airborne remote sensing offers a potential capability; the resolution is greater than that offered by satellies and, because of the spectral characteristics of the sensors, species distinction is possible.

Radar would also offer some answers, because of its penetration ability it has been found that it is possible to accurately map certain species' differences.

Closely linked to the disease monitoring and stand quality is the question of yields. Again further research is being done. Models are being adopted to help in this process, and, there are indications that remote sensing will be a more efficient tool for yield prediction.

Every year the government needs to know the status of the forest industry. Legislation requires companies to supply aerial photography to the Department of Natural Resources to allow for harvesting. The large companies have used GIS for a number of years. All areas are mapped, and the data from each parcel is carefully managed through the GIS. However what cannot be monitored efficiently are the hundreds of areas belonging to farmers and private landowners. In order for this to be done they need to have good temporal information. Land under trees attracts preferential tax rates and the present policing method is by inspectors driving around checking visually. This is not only expensive, it is very inefficient. The government is believed to lose considerable revenue from this process.

Many departments have stated their requirement for a base year for geomatics. Aerial photography is of differing ages and hard to integrate. Digital data for the whole province could be acquired in one year to provide one common base. From this it would be possible to do species and cut mapping, and hopefully a disease inventory. Multitemporal data is also of prime importance to the government, and provision of this should be made. Digital imagery could be used for this process: possibly providing data twice a year - in the Spring and Autumn - to help in the monitoring process.

The Canadian Forestry Service (CFS) has recently set up a facility in Edmunston to carry out research into the use of remotely sensed data for forestry applications. Its objective is to acquire digital data, and develop models which will then be passed on to the private sector.

MARKETS
Forestry

Forestry offers many possiblities for remotely sensed data. Forestry is a major revenue generator and the companies involved are encouraged to be progressive, and they are interested in pursuing new management techniques. It is felt that there is a large market for digital imagery and, as the industry is dynamic, continued use would be assured.

3.3 Mining

Like forestry, the mining industry has used aerial photography for many years, primarily for lineament mapping. Attempts have been made at vegetation mapping to determine different lithological boundaries, and this has met with limited success. Recently, hard copy satellite imagery has been used for the same purpose. However, there have been limitations to using digital data. The geologist is, in essence, attempting to find sub-surficial deposits. There are many geophysical methods to help him interpret the landscape, and these are well established, with Canada leading the world in airborne geophysics. These methods allow a relatively cheap way to map lithology.

An airborne geophysical survey over a property will help the geologist interpret the area. Coupled with geology maps, which in many cases are poor, he should be able to find areas of interest which will require ground follow up. However, air surveys are normally flown at 100 m plus spacing and there is evidence that many targets are missed. Optical geophysics (or geobotany) is starting to be taken seriously. Vegetation is very specific in its growing requirements and any chemical or mineral stress may be detected in the vegetation's reflectance. There are many documented cases where it has been shown that vegetation on copper rich soils show stress.

There is continuing research and development with these new techniques, however it will take considerable marketing effort to get the traditionally conservative mining community to accept these methods.

Radar's unique properties have applications for soil mapping. Soils are indicative of geology and it is therefore possible to map the different structures. As radar can detect roughness and moisture content it should also be possible to map differing structural units. Radar is not dependent on weather conditions and there is a huge potential to use the data for soil mapping, especially in the Third World.

MARKETS
Mining

By its very nature geology is not dynamic, and while the market for products would initially be strong it may not indicate a growth market once the initial data is obtained. Thus the market for remote sensing from the mining community would depend on geobotanical methods becoming more acceptable. It is felt nevertheless, that facilities must be provided for this section of industry as it is a large employer and revenue producer. Throughout the region there are some companies already actively using the technology and it is believed that this will expand with increasing awareness and availability.

3.4 Fisheries

Landsat and Thematic Mapper data have been of little use in fishery studies being only able to pick up surface reflectance as the spectral bands have not been ideally located for oceanographic applications. Some areas that have been studied are plankton, sediment loading and water temperatures. A considerable amount of work in these areas has been carried out with CZCS (Colour Zone Colour Scanner) on NIMBUS 7 satellite. The future generation of satellite sensors will remedy previous deficiences. Airborne sensors are currently available with the necessary spectral bands to carry out these studies.

Plankton is known to bloom, and this is detectable. Using models it is possible to assess fish productivity. This method can be best used in shallow water areas or where the blooms are close to the surface. Blooming occurs rapidly and therefore requires airborne data as it is not possible to obtain timely imagery from satellites.

Sediment loads and organic content affect many sea creatures. Mapping sediment can give an indication of water quality, currents and dispersal patterns.

To be able to assess fish stock, food productivity has to be known, and plankton is one indicator. The temperature of the water and the quality of the water will dictate plankton blooming and extent. Recently New Brunswick initiated some studies into aquaculture, aimed at the seafood industry, particularly shellfish, and lobsters, which grow in profusion in the Bay of Fundy. Both of these creatures are very particular about their environment.

Submergent vegetation such as kelp can be mapped and volumes estimated. In shallow coastal areas, different bottom classifications, both grasses and sands, can be identified. Water depths, rocks and sandbars can also be accurately charted

to depths of 15 metres dependent on the turbidity of the water.

3.5 Other Markets

3.5.1 Crop Monitoring

The Department of Agriculture is keen to see a system where crops can be monitored effectively. The need for this is twofold, firstly to control overcropping and secondly to police certain crops.

Overcropping has led to very serious erosion along the St. John River valley especially around Grand Falls. The main culprit is the potatoe, which has been a traditional crop for many years. Because of the way it is planted (in rows) the runoff has led to large areas being heavily eroded. To help stop this the Department would like to more effectively police where these crops are grown. This would help in reducing erosion, and subsequent claims for crop loss.

The government also needs to be able to verify those claims of preferential tax rates for wood lots. Temporal data would help cut down false claims.

GIS can play an important role: lots can be recorded, with the owners names, and all crop data. This data base can be constantly updated for tax purposes. The New Brunswick Department of Agriculture has recently purchased a CARIS system which can provide this capability.

Other than potatoes, the only commercial crops are blueberries and apples. Grain crops are not grown extensively due to heavy subsidies to import prairie grain. The situation is unlikely to change dramatically. Remote sensing is not seen to have growth in this area.

3.5.2 Erosion Control

One source of erosion is runoff, especially during the spring thaw. With a frozen ground, water will carry away almost anything that is not anchored. Predictions for the amount of runoff are based on snow and ice monitoring for remote sensing data.

3.5.3 Ground Water Quality And Landfill Site Monitoring

Many areas of the province have been found to have toxins in the water above the acceptable limit. To monitor this, it should be possible to infer the toxin level by the stress on the vegetation and measuring changes over time. This is an obvious area for applications development which can have implications elsewhere. Ground water is being polluted throughout the world by fertilizers, and leachate from landfill sites has become of increasing concern. GIS will be essential for monitoring these effects.

3.5.4 Civil Engineering

Increasingly civil engineering companies are realizing the potential of remote sensing, e.g. for route planning of roads and hydro lines. Soil and rock mapping is possible, slope statistics, mapping existing infrastructure, and environmental assessment are all applications of interest to the engineering community.

3.5.5 Environmental Monitoring

Mining companies have expressed an interest in methods to monitor pollutants from the many sources at a mine site, i.e. slag heaps, settling ponds, etc. Current remote sensing technology can provide data that would be able to do this. By selection of the correct sensor it is possible to measure vegetation stress giving an indication of seepage and ground water quality and the extent of the problem.

3.5.6 Mapping

In all of the previous applications the common denominator has been mapping. For each it is essential that ground data is (a) up to date, and (b) accurate. The Land Registration and Information Service (LRIS) has recently begun the task of digitizing some of its maps. In 1984, LRIS completed the production of two series of maps for the Maritime provinces. A resource map at 1:10,000 and an urban line map series of 1:1,000 and 1:2,000. The original maps also need to be updated, as they were started back in the late 1960s. With modern technology it has been decided to provide both series in three forms: the hard copy, the topographic database as it was

surveyed, and a cartographic base. This is both costly and time consuming. LRIS would like a base year from which to work, and it was suggested that TM data be used for rural areas and SPOT panchromatic for urban areas. Areas would be classed according to set parameters and would include agriculture, urban, marshland, etc., - standard cartographic classes. An annual updating of the data base would be needed. Although initially requiring an increased budget, the cost would be retrieved by having the ability to monitor land use changes for tax purposes routinely. LRIS would also like to map forest cuts: again satellite imagery can provide this. Once the area has been classified it would be incorporated into a GIS which could be routinely updated. LRIS's needs would provide a guaranteed amount of work every year.

3.5.7 Flood Monitoring

Throughout the province flooding has been a major problem over the years particularly the St. John River between Grand Falls and Woodstock, around Fredericton and at the mouth around St. John. There are three main causes of the flooding: snowmelt, ice jams and rainfall.

The snowmelt creates large amounts of water. Because the ground is frozen, very little seeps in as ground water. During the spring thaw this problem becomes particularly acute, with alternating freeze thaw cycles. Ice jams cause damage to bridges and tend generally to be more destructive than runoff. They often occur when upstream ice melts before downstream ice, with flow impeded by structures, islands or shoals.

The Federal and Provincial Governments have a flood monitoring station in Fredericton, which routinely uses satellite data. They use NOAA (meteorological satellite) images to estimate the area covered by snow, and with field observations of the depth and type of snow, they work out the water equivalent. With this they can estimate runoff and the effect on the river later in the season. This system seems to work well. However, in discussion with them, they would like to obtain constant data on the condition of the ice break up: either TM or SPOT data should suffice both having the necessary resolution. There may also be times when aerial reconnaissance would be necessary.

With large amounts of money for flood control and repair it is believed that insurance companies would be interested in more cost effective methodologies for forecasting.

Flooding is an annual problem and so there is a routine requirement for improved monitoring services.

3.5.8 Ice Monitoring

Radar is proving a powerful tool in ice monitoring. However the present airborne systems have limitations in providing good temporal data, except for slow moving ice. Many millions of dollars are spent each year tracking ice movement and icebergs. Off the east coast there are oil fields, with large platforms which can be easily damaged by icebergs. The tracking of these is of paramount importance. Savings to the oil and gas industry are estimated to be in the order of $26 million annually (1986 prices)(*). However data must be near real-time to be most cost effective. Shipping is also affected by ice. If effective data were available to the industry, savings would amount to some $21 million (1986 prices)(*). It should also provide better weather forecasting facilities and thus help the fishing industries.

3.6 Future Markets

During the next decade a series of radar satellites are to be launched. Unlike the present platforms these are active systems. The European Space Agency's (ESA) ERS-1 is due for launch in 1990, JERS, Japan's in 1992, and Canada's Radarsat in 1994. Depending on their success more will likely follow. There has been experience of radar satellite technology with Seasat and the Shuttle Imaging Radar (SIR) programs, but this is limited. The next generation sensors will provide improved technology with different bands of information.

Canada's Radarsat will be a joint effort with the UK(**) and USA, although a firm commitment from the former has yet to be made. On board will be three instruments; a high performance Synthetic Aperture Radar (SAR) with normal, high resolution and SCANSAR modes, An Along Track Scanning Radiometer (AATSR) and a radar altimeter. The design life for the craft is five years. The SAR sensor will offer day/night all weather coverage. The high resolution will allow users to obtain images 55 km wide

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*Radarsat Economic Review and Assessment, Price Waterhouse

**Recent information indicates that the UK will not participate in Radarsat. The ramifications of this decision are not known at this time.

with an 8 m resolution. The "normal" mode will provide 100 km swaths and 28 m resolution and "scanner" mode will offer 500 km swaths with 100 m resolution. A stereo capability will be available due to the pointability of the sensor.

The AATSR will provide sea surface temperatures for climatic and demographic studies. The radar altimeter is expected to provide information on surface currents, wave heights, deep ocean tides and the thickness and extent of ice.

Through establishment of applications and capability to process radar data, New Brunswick and Canada will be in a position to provide data processing services, with applications for specific software to manipulate this new form of data. Opportunities for exploitation of this data will be for those organizations now established and providing services using current satellite technology.

Radarsat will provide near real-time imagery for ice movement. This will be of benefit to the fishing and oil and gas industries. By being able to monitor ice, it will allow both sectors to save on down time and movement of ships and personnel. This has added significance with the proposed shipment of oil and natural gas from the Arctic through the North West Passage and down the coast of Labrador. Being unaffected by weather, imagery will be obtainable and transmitted year round to all ships. The present airborne systems are at the mercy of the weather, and the large areas involved make it very expensive for routine coverage.

For agriculture, Radarsat will increase the level and quality of information available for crop forecasting. This is very significant for the Canadian Wheat Board as the crop states in other countries, e.g., Russia, China and Argentina will be monitored. Forecasting errors will be reduced, and, because the satellite is Canadian, data will be easier to obtain.

For non-renewable resources Radarsat holds many promises. Terrain morphology can be mapped, enabling subtle changes to be mapped. Lineaments and faults can be distinguished. Stereo capability will add to its advantages. For Third World countries, especially those in the tropics, the all weather capabilities will lead to major opportunities.

The covering of a landscape by natural vegetation lessens the geologist's interpretation capabilities. With radar it is possible to interpret the landscape below the vegetation.

MARKETS
Future Markets

Opportunities exist for using the region to develop a number of specific applications for use of Radarsat data, e.g., studies in snow geophysics, runoff, biomass mapping and oceanography. Snow geophysics studies should result in better runoff predictions and all its implications for flood forecasting.

Three other applications have been identified:

1. Surface runoff forecasts for hydroelectricity,

2. Land use mapping at 1:250,000 in countries subject to frequent cloud cover, and

3. Revision of 1:250,000 maps for the same countries.

Biomass mapping has some important economic benefits. As the region is strong in forestry technology, it should be possible to use New Brunswick as a radar test site.

Ocean studies would benefit all provinces in the Maritimes.

3.7 Market Summary

In summary there are many application areas in which remote sensing can be used throughout the province for resource management. Both LRIS and the foresters want a base year. Annually the flood monitoring department needs data, as do the foresters - this could provide a guaranteed amount of work every year and from this base it should be possible to establish a market for other applications.

There are many more uses and applications which need development. With the present infrastructure this should be possible. UNB has facilities as does COGS, and the use of students should be encouraged in this process.

Radar also offers very exciting prospects and radar test sites are needed throughout the world. Any organization that is actively involved in the development of specific applications for radar would have an export spin off.

CHAPTER 4

FORECAST BUSINESS

This survey of opportunities for the application of remote sensing services within New Brunswick has determined that there are three priority markets which would require ongoing services;

o LRIS

- the provincial forestry departments
- the Department of Municipal Affairs
- Water Resources.

Both LRIS and the forestry departments would like a base year of digital data to build upon, while the flood monitoring stations would like to augment their existing meteorological satellite data sets with information on the condition of ice breakup. This information could be obtained from either Landsat TM or SPOT, and integrated with existing data sets in a GIS.

This routine requirement for change detection would provide a guaranteed minimum amount of work each year.

The New Brunswick Department of Natural Resources have a program to acquire airborne optical imagery using MEIS, over the next two years in collaboration with CFS at Edmunston and the Department, who are both commited to programs to help monitor disease, yields and logging. A facility in New Brunswick could provide services related to this program for data stripping, quality assurance, geometric correction, integration into a GIS, indexing, and archiving. While the detailed methodologies may not yet be in place for using this information operationally, establishing a mechanism for incorporation with a provincial data base, as soon as possible will prove beneficial in the long term.

FORECAST BUSINESS

The acquisition of any other airborne data sets in New Brunswick could be treated in a similar fashion, e.g., Radarsat simulation studies.

To establish cost effective applications for this technology in other market sectors will require a substantial amount of marketing and creation of an awareness for the products. At present there is a lot of active exploration within the mining community using 'flow through' share investments and companies are thus more receptive to accepting new technologies. Unfortunately the Federal Government has decided to phase out these tax advantages over the next two years. The fisheries/oceanographic market appears to be on the threshold of using new information, to assist in the management of their resources, and it is felt that once a facility exists for offering this capability the market will grow, as new applications are identified.

Many problems faced by New Brunswick are similar to those of the other Canadian provinces, and of similar sized developed and developing nations. Bearing in mind that information technology does not have to be market based, very good opportunities exist for exporting this expertise abroad, where the market for spatial technologies is large.

CHAPTER 5

FORECAST EMPLOYMENT

Within a newly established service company it is anticipated that a minimum of four full time positions would be required by the end of the first year. The mix of personnel would cover marketing and sales, image processing specialist, computer programmer with administrative and secretarial support. With the potential for growth it is considered that by the end of year two, approximately ten full time personnel would be required.

The role of the further education establishments is crucial in supplying professional and technical personnel. The computer department at UNB runs courses in image processing, so image processing specialists would be available as would computer programmers. Most universities throughout the region have computer programming courses and could supply expanding requirements. Where there is a shortfall is in the applications of remote sensing, and this is not only prevalent within the region but universally. However both the forestry and surveying departments at UNB have units in remote sensing.

Any new service facility must actively promote its expertise and generally improve the awareness to industry of this technology. It is essential to provide workshops and training courses which managers from both government and industry can attend to gain exposure to the availability of remotely sensed data, and learn how it can be applied to their particular applications.

Similarly for GIS, an ignorance abounds for this technology which has huge potential for almost everyone involved in spatial data management. Workshops would create the awareness which is needed for people to understand the technology, to use the products, and through its use, generate additional employment by increasing the need for newer and improved products and services.

CHAPTER 6

SUMMARY AND RECOMMENDATIONS

The survey shows that the Province of New Brunswick is lacking in remote sensing facilities and data processing capabilities. In a society becoming increasingly more reliant on information and information technology, this needs to change. There appears to be an ignorance of data availability and services for providing interpretation and end products. This results in a fear of remote sensing technology and a reluctance to use it. A market and applications development program is needed.

Because of this situation there is at present a small market. There is potential for more users and a successful business but this will only come from education and a demonstration of cost effectiveness and through a commitment on the part of the province to encourage an acceptance within their user departments.

It was found that image processing and consultancy facilities would be used if they were available.

Forestry is one industry that realizes the benefits of remote sensing. With the facilities at Edmunston the forestry applications will grow. Remote sensing can help in the monitoring and control of diseases, help in stand monitoring, and measuring crop yields. There is no doubt that forestry would provide a commercial remote sensing facility with ample work.

Some mining companies are already using digital imagery. The majority however have a reluctance towards using it and would appreciate help in interpretation, processing and, simply, acquiring the data. Although this market is not dynamic at present, the future does look better. Radar will provide another tool to assist in geomorphological interpretation and will allow areas hitherto unexplored, to be better understood. Geobotany offers another technique that will increase in use as the community understands how this data can be integrated with

traditional exploration tools.

Applications in fisheries and oceans are limited at present but will expand with accessibility of services. Again radar offers some possibilities, and should be developed in the short term.

Of the other areas of application, mapping, and snow/ice monitoring are important. For mapping, LRIS would like temporal data to update its data base. This is required for tax reasons and this is important for government revenues! Constant updating of snow/ice condition is needed to anticipate flooding. If this can be made more accurate and efficient many millions of dollars can be saved, justifying the cost of data acquisition. These would offer ongoing routine work.

The New Brunswick Government is committed to supporting CARIS and encouraging their departments to use GIS technologies. This will also encourage the use of digital imagery. The Champlain Institute will act as a catalyst for technology exposure of the province. This should be actively supported by the consortium. The work being carried on in GIS will add to the growth of this technology in the future.

Radar technology offers numerous research opportunities with as yet untapped applications. The province should build up its strength in this field. It is strongly suggested that New Brunswick apply to become a national test site.

There is also the opportunity to use St. Margaret's as the national archive centre from which all Radar data can be purchased. This would generate additional revenue and expertise within the province. It is very important that the user community comes to grips with the large amounts of data available at present and forecast for the future. This has to be stored, indexed, catalogued and archived properly and with radar this must commence at the start, prior to data acquisition, not halfway through. The higher education establishments throughout the region are well endowed with some departments considered to be among the best nationally. For remote sensing and GIS both UNB and COGS in Lawrencetown, are active users of remotely sensed data. Edmunston will soon join this list. They should be able to supply an adequate number of suitably qualified people for job opportunities that will arise.

It would be naive to believe that there is enough business in the province to justify a commercial remote sensing facility at this time. However it is very possible to reach commercial profitability by expanding to national and international markets. Information technology does not have to be market

based, and therefore building on existing strengths, remote sensing facilities can pay off for the province, if an appropriate strategy is implemented. Export potentials are enormous. It is difficult to predict future employment opportunities, as this will depend on the success of the enterprise and how it sells the technology already developed, carries out applications development, and in parallel, develops the market.

Above all it must be emphasized that no facility will survive unless a campaign of education and awareness takes place. The current ignorance must be surmounted in order to get the technology of remote sensing and geomatics more accepted and used by managers in industry and government.

APPENDIX A

PEOPLE CONTACTED

PEOPLE CONTACTED

People interviewed for the Survey:

Alan Brackley	J.D. Irvings, Woodland Division
Charlie Morrisey	Durham Resources
Dr. Don Pollock	Searight Resources
Bill Graham	Noranda Exploration
Peter Dimmell	Lacana Minerals
Olly Bonham	Rio Algom
Russell Crosby	C.I.T. (Miramichi Pulp and Paper)
Wayne Lockart	Lockart Exploration Services Ltd.
*Gerrit Van Raalte	Canadian Forestry Service
*Neville Nandlall	N.B. Dept. of Natural Resources, Crown Lands
Thom A. Erdle	N.B. Dept. of Natural Resources, Timber Management Branch
Don Leckie	Canadian Forestry Service
Lee Frizzell	Trainor Surveys
Doug Morgan	Trainor Surveys
*Sherif H. Fahmy	Land Resource Research Institute, N.B.
Art Ruitenburg	New Brunswick Geology Dept.
Don Hoy	Lacana Minerals
Brent Rowley	Maritime Remote Sensing Committee
*John Henderson	Spider International Ltd.
*Rao Irrinki	N.B. Dept. of Natural Resources, Mineral Resources Division
*Michael Dillon	N.B. Dept. of Agriculture
Ron Brown	C.C.R.S.
Ed Langham	Radarsat
Steve Petaherych	A.E.S., Downsview
*Eugene Derenyi	UNB Dept. of Surveying
*Lawrence Peters	N.B. Dept. of Municipal Affairs, Water Resources
*Mary Ogilvie	L.R.I.S., Fredericton
Ernest Brooks	Noranda Exploration
John E. McCombe	Tenoga Consultants
Don Carroll	Dept. of Natural Resources and Energy, Geological Surveys
John A. Leslie	John A. Leslie and Associates Ltd.
Salem Masry	Universal Systems Ltd.
Andrew Wenning	N.S. Dept. of Mines and Energy
Ted Urquhart	Urquhart Dvorak Ltd.
Jean Game	C.C.R.S.
Bill Bruce	C.C.R.S.
Vern Singhroy	O.C.R.S.
*James Chandra	N.B. Dept. of Commerce and Technology, Science and Technology
John Stevenson	Nexus Resources
*Janice LeBlanc	N.S. Dept. of Natural Resources
*Don Carlin	N.B. Dept. of Natural Resources

PEOPLE CONTACTED

Many people at the Prospectors and Developers Conference, Toronto, March 1988.

*Present at the Remote Sensing meeting, Fredericton, February 1988.

APPENDIX B

STUDY METHODOLOGY

STUDY METHODOLOGY

A literature search was initiated to find out as much as possible about the region and the current use of the technologies. The following were researched:

1. GIS
2. universities and availability of courses
3. infrastructure of the region
4. companies
5. federal government
6. RADARSAT
7. future trends in digital imaging technology

At the end of February representatives from Marshall Macklin Monaghan and MONITEQ were invited to address the remote sensing committee in Fredericton, at which 13 people from local interested groups were briefed on the proposal and on how the survey was to be carried out.

Over the course of 5 days, everyone at the committee was approached individually and questioned about their involvement (or their department's involvement) in remote sensing and what they would like to see in the future. Other parties were contacted by telephone.

At the annual Prospectors and Developers Conference in Toronto, many mining company personnel with interests in the Maritimes were solicited for their opinions of remote sensing and, again, what they would like to see in the way of remote sensing facilities in the region.

A visit was made to the RADARSAT offices and CCRS in Ottawa to discuss the survey which was met favourably. The Ontario Centre for Remote Sensing (OCRS) had the same positive reaction.

During the course of the survey many people have been asked their opinions; these have ranged from mining companies throughout the country to airborne companies those actively involved with remote sening. All have reacted favourably and added invaluable information to the survey.

QUESTIONNAIRE (for Appendix B)

I would like to know if your organization uses any remote sensing products.

YES

1. How often?
2. Which products?
3. For what purposes?
4. What do you wish to see from these products?
5. Where do you at presently obtain these products?

5a. Are you satisfied with the service?
5b. If not, why not?

6 Who is responsible for it?
6a. Who does he report to?

7. Is there a budget for R.S.?
7a. How much?

8. What stature does it have within the company?

9. Can you forsee any developments that you consider important for your continued use of R.S. products?
9a. Any suggestions?

NO

10. Why not?

11. Would you be interested in using R.S. products?
11a. If yes, for what reason?
11b. What would you like to see?

12. Can you forsee any trends within the company that would encourage you to use any sort of R.S.?
12a. How about trends within the industry?

13. How would these fit into the company's product base services?

14. Is your company familiar with GIS?
14a. Does it use it? (if no go to 16)
14b. If yes, which system?
14c. What for?

15. Does the company use aerial photography for any reason? (if no go to 16)
15a. If yes, for what?
15b. Do you do your own flying or sub-contract?
15c. Do you do your own interpretation or sub-contract?

16. Why does your company not use either of the above methods?

17. Does your company have any image processing facilities?

Yes

17a. What system do you use?
17b. Do you have someone trained in image processing?
17d. Does someone else do the work?
17e. Are you happy with the service? Any comments.

No

17c. Would you be interested in acquiring I.P. facilities?

18a. Would your company be willing to train someone in I.P.?
18b. Would your company be willing to train someone in GIS?

19a. Has your company ever used Radar imagery?
19b. If yes, what for?

20. Has your company ever heard of
a) Moniteq
b) Marshall Macklin Monaghan
c) Universal Systems Ltd.

21. Are you familiar with airborne Electro-optical remote sensing e.g. MEIS, Daedelus, PMI/FLI?

Yes

21a. Have you ever used it?

No

21b. Could you forse anytime when it would be used?

22. Does your company have any sort of digital data base?

23. What is your company's primary product?
a) service to the R.S. industry
b) resources
c) regulatory
d) Public Service with responsibility for data base management?

24. Any comments?

APPENDIX C

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APPENDIX D

OBJECTIVES OF A "NEW" NEW BRUNSWICK COMPANY

OBJECTIVES OF A "NEW" NEW BRUNSWICK COMPANY

A Remote Sensing and GIS Service Company

To facilitate the acceptance and flow of remotely sensed digital imagery to end users on a commercial basis.

By integrating remotely sensed data with Geographic Information Systems (in particular CARIS of USL) but to include other systems as required by users, in order to provide a comprehensive service for resource management decision making.

To carry out applications development specific to New Brunswick and market this capability nationally and internationally.

Establish an infrastructure for processing current and future remotely sensed data sets, e.g. Radarsat.

To provide training programs on availability of remote sensing data sets and integration with GIS to end users and professionals.

To assist in technology transfer from government and university to industry through identification of opportunities/requirements for emerging technology and geomatics.

APPENDIX E

PRODUCTS

PRODUCTS

Short Term (1-3) Years)

1. Satellite and Airborne image data processed to various levels, to meet client requirements. Available on tape, compact disc, or floppy disc. Includes raw data, geocoded data, thematically classified data, digital terrain data and GIS manipulation and map products.

2. Applications Development and Consultancy service for defining and implementing pilot projects, orientation studies and providing technical support on data acquisition, processing and interpretation.

3. Program and Project Management

4. Providing training programs to end users and professionals.

5. Image Processing Service Facility, Consultancy, and technical support to users with own data.

Future (3-5 Years)

1. Software specific packages for processing and integration of data, data enhancement and specific applications.

2. Peripheral (Hardware and Software)
   Airborne/ground station quicklook, Airborne integrated GPS/INS systems, Airborne data logging products, Data transcription systems, Image processing and information networking, Desk top work station image processors, Hard copy capability.

APPENDIX F

DATA AVAILABILITY

Data Availability

Traditional Data Sets	- Base Maps - Property Maps - Forest Inventory Maps - Aerial Photography - Airborne Geophysical
New Data Sets (Satellite)	- Multi Spectral Scanner (MSS) - Thematic Mapper (TM) - Meteorological Satellites (NOAA, GOES)
New Data Sets (Airborne)	- Multi Spectral Scanner (MSS) - Modular - Programmable Multi Spectral Imager (MEIS) (PMI)
Future (Satellite)	- SPOT (France) - Radar Sat. (Canada)
1990's	- Research Satellites (Various) - SPOT II, III and IV (France) - Landsat 6 and 7 (U.S.A)

Data Distribution (Satellite)

Federal Government Agencies (Primarily Canada Centre for Remote Sensing, Ottawa).

Provincial Government Agencies
Universities (U.N.B., COGS)

Private Companies; (Mining, Oil and Gas, Engineering)

Data Distribution (Traditional)

Federal Government Agencies
Provincial Government Agencies
Local Government
Resource Companies
Survey and Mapping Companies
Airborne Photogeometry Companies

Data Distribution (Airborne)

Innotech Aviation (Ontario)
Moniteq Ltd. (Ontario)
Interra (Alberta)
Conait (B.C.)
Aerial Mapping and Photography (Newfoundland)

APPENDIX G

COMPETITION

COMPETITION

Competition for these services within the Atlantic region is very limited. For image processing, it is non existent, except through the University and College of Geographic Sciences (COGS) in Lawrencetown. These facilities are however primarily for the use of students and the private sector has to fit in with existing schedules. There appears to be scope to have facilities available for the public. In discussions with many people, it was found that one reason for not using this technology was the lack of facilities throughout the region.

For data interpretation there are a few sources available. There are individuals who would provide this service, but, in essence, it was found that the province lacks coherent capabilities in this field. It is felt that with good image processing facilities the requirement for consultancy would increase.

Nationally there is some competition but none specifically addressing the several aspects of remote sensing as proposed herein. It is felt that these would not pose a signficiant impediment as the overall problem remains a need for cost effective applications, which exploit the technology. Also, the market is large enough to support more entrants into the consultancy field.

The field of Geographic Information Systems is a growing one, and Universal Systems already has 10 years of development and sales of CARIS. This has given it a unique niche in the market. Its product is tried and tested and supported throughout the region and has recently had substantial commitments from the government of New Brunswick and Sperry Burroughs to continue development. Throughout the province the main competitor is the ARC/INFO system by ESRI. The Canadian Forestry Service uses it and therefore it has been adopted by the forestry companies as their standard. However the two systems will talk to each other and allow access to each others data. Apart from this area there is no competition, and with the provincial government's commitment to using CARIS, the potential growth in sales and services is good.

Nationally there are competitors for GIS, but with the huge growth in this market there should be ample opportunities. Nearly every municipality in the country is looking into the acquisition of a GIS system to allow better archiving: the growth potential is enormous, and CARIS with its history should be well positioned to take advantage of this.

APPENDIX H

THE CONSORTIUM

THE CONSORTIUM

Background material for each of the three members of the consortium, Universal Systems Limited, Fredericton, New Brunswick, Marshall Macklin Monaghan Ltd., Toronto, Ontario, and MONITEQ Ltd., Concord, Ontario, are included in the Appendices.

A brief summary of the relevant capabilities of each company is included here:

o Universal Systems Limited (USL)

- Technology transferred from UNB
- Geographic Information Systems product development
- Geographic Information Systems product sales.

o Marshall Macklin Monaghan Ltd. (MMM)

- Management experience for large value, multiple year and critically scheduled projects
- Aerial photography services
- Land information systems development and practice
- Digital photogrammetry and digital terrain modelling
- Geodetic hydrographic, geological and topographic surveys
- GIS services - ARC/INFO and CARIS
- Multi disciplinary consulting services
- International project experience.

o MONITEQ Ltd. (MQ)

- Technology transferred from Canadian government departments and Ontario universities
- Remote sensing imaging systems and applications development
- Hardware products for digital data capture, software for geocoded digital data and producing thematic maps
- Applications development through data acquisition and data processing services
- International services and marketing.

The activities which the integrated capabilities of the three companies bring to a geomatic system are as follows:

Applications Development

There is essentially no organized approach to applications development within the province or for that matter in Canada. At present applications' requirements are dealt with on an ad hoc basis. It is the experience of the consortium that while applications must be market driven, they must also be based on the best judgement of professionals within the industry. The consortium must be in a position to anticipate user needs even

if the users have not yet perceived them.

A detailed analysis of user needs has not yet been fully evaluated. This needs to draw on a wide range of experience with user requirements, e.g.

- Spatial data requirement
- Thematic information requirement
- Spatial and thematic data integration
- Data sources and availability
- Data base management maintenance and use
- Presentation techniques.

Product Development

As with applications, there has been no organized approach to development of products. Again the development must be driven by both the expressed market need and by the industry's understanding of what users would use, cost effectively if it were available. Product development activities require a multi disciplinary approach which is available through the consortium.

Marketing and Sales

Establishing and maintaining effective client bases in the geomatic industry, requires personnel who are well qualified users of geomatic systems and who understand the theory and practice of a full range of geomatic systems techniques. Again the consortium has demonstrated experience in this area.

Quality Assurance

The surveying and mapping professions with their associated activities have developed excellent quality assurance methodology much of which will be transferrable with some modifications to GIS. Where different and new sets of quality criteria are required they will be developed as appropriate. All three members of the consortium have established their respective credibility within the market by a provision of quality service to clients.